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Report, drawn up by Samuel Hunter Christie, Esq. M.A., F.R.S., on Mr. Faraday's paper, entitled "Experimental Researches in Electricity:—Third Series."

Report.

§ VII. *Identity of Electricities from different Sources.*
§ VIII. *Relation, by measure, of Common and Voltaic Electricity.*"

In order to prove the identity of electricities derived from different sources, the author in this communication, after viewing the phenomena exhibited by electricity, shows, that although some effects are most readily derived from a particular source, yet none are peculiar to such source. The principal points in which ordinary and voltaic electricity have been considered to differ, are the inefficiency of ordinary electricity to produce chemical decomposition, or to affect a magnetic needle like voltaic electricity. The experiments of Wollaston were made early in the application of electricity to chemical decomposition, before the general law of the transfer of the elements to the poles of the battery had been indicated; yet his 4th experiment, in which electricity from the machine was passed through a solution of sulphate of copper, and his 5th, where it was passed through a solution of corrosive sublimate, have the true characteristic of decomposition by voltaic electricity: and it is surprising that those who advocate a distinction between these electricities should have ventured to overlook these experiments, when they bring forward the experiment of the decomposition of water, as deficient in this characteristic of the transfer of the elements *. This circumstance, however, induced Mr. Faraday not merely to repeat Wollaston's 4th experiment, which he did with complete success, but to adopt different arrangements; and by these, with ordinary electricity, he obtained, in various instances, chemical decompositions having all the characters of decomposition by voltaic electricity. Whatever doubt, therefore, may have been thrown upon this part of the subject, he has entirely removed it.

The author has also removed the doubts which it appears had been entertained respecting the conclusion of M. Colladon, in consequence of the failure of his experiments in the hands of others. By a particular arrangement connected with the glass inclosing the galvanometer, and by retarding the passage of the electricity through its wires, by means similar to those by which gunpowder is most successfully exploded by an electric discharge [*], which he also employed to effect chemical decomposition, Mr. Faraday succeeded in causing the needle to deviate, both by the discharge of a battery, and by electricity passing directly from the conductor of the machine. In justice to M. Colladon, we must remark, that the account which he gives of his experiments affords no reasonable ground for doubting the accuracy of his conclusions : the details are clear, and the numerous results unequivocal [†]. We may also notice, that, in the same memoir, M. Colladon gives an account of some very interesting experiments, made with a similar arrangement, on the magnetical effects of atmospherical electricity, by which its power of causing deviations of the needle is satisfactorily established.

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* Phil. Trans. 1832, p. 282, note.

Mr. Faraday, in the comparison which he makes between the effects produced by ordinary and by voltaic electricity, shows that the following, though differing in degree, are common to both, viz. attraction and repulsion, evolution of heat, magnetism, chemical decomposition, physiological phenomena, the spark. To these proofs of the identity of the electricities from these sources may be added, that batteries have been charged from the voltaic pile, and that the shock from a battery so charged could not be distinguished from that of the same battery charged to the same extent from the conductor of a machine [‡]. We consider that this alone is strong evidence in favour of the identity of the electricities, although we do not quite agree with Van Marum that it is conclusive.

The effects hitherto obtained from magneto-electricity, the author considers to be, evolution of heat, magnetism, physiological phenomena, the spark. He has not himself effected chemical decomposition by means of it; and he considers that the effects which have been obtained by others do not show true polar decomposition, but are similar to those obtained by Wollaston in the decomposition of water.

That magnetism and physiological phenomena are the only effects which have yet been obtained by means of thermo-electricity, the author attributes to its low degree of intensity.

Mr. Faraday considers that the identity of the electricity of the torpedo with common and voltaic electricity is satisfactorily established, although some effects, attraction and repulsion, due to a state of tension, evolution of heat, and the spark, have not yet been obtained : and in this we fully concur.

The general conclusion which the author draws from the collection of facts which he brings forward, is, that " electricity, whatever may be its source, is identical in its nature ;" and he attributes the difference in the degree to which the phenomena, when originating in different sources, are observed, to the variable circumstances of quantity and intensity. This manner of accounting for the difference in the phenomena due to voltaic and to common electricity was adopted very early in the inquiry, common electricity being considered as exceeding in intensity, but deficient in quantity. We however think, that it would be more in accordance with the phenomena to state, that as some effects require continuous action, they can only be obtained from ordinary electricity by rendering the quantity accumulated on a given surface (which quantity is a measure of the intensity,) available as a source of such action.

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[*] For this method of ignition we are indebted to Mr. W. Sturgeon. Phil. Mag. 1826.

[†] Annales de Chimie, 1826, tom. xxxiii. p. 62.

[‡] Annales de Chimie, 1802, tom. xl. p. 289.

Although we agree with the author in the conclusions which he draws respecting the identity of electricities, yet there is one point, the mode of their conduction, in which they have been said to differ, on which we wish that he had made some remarks. The current of voltaic electricity runs through the mass of the conducting wire, and its intensity is diminished by increasing the length of that wire; and the same is the case with magneto-electric currents: but common electricity, in a state of tension, resides at or near the surface of a body, and has been considered to be so conducted *; and the shock has been found not to be diminished by the length of the wire through which it takes place. We would however ask, whether it is not a gratuitous assumption to state that electricity is conducted on the surface, because it exists there in a state of tension? That it exists near the surface when in a state of tension, is due to the repulsive force which its particles exert upon each other; and when they are relieved from tension, will not the same repulsive force spread them through the mass of the conducting body? With regard to the shock from a battery not being diminished by the length of the wire through which it takes place, does it not arise from the same quantity of electricity on a given surface being passed, when the equilibrium is restored, between the outside and inside of the battery, whatever may be the length of the conducting wire? We regret that the author's attention was not drawn to this part of the subject; for we feel assured, that had it been so, he would have met the objections which on this ground have been urged against the identity of the electricities. Possibly he was so fully convinced of the futility of these objections, that he considered it unnecessary to notice them.

The second section of this paper details experiments for determining the relation, by measure, of common and voltaic electricity.

The author first determines that the magnetical effect of a given quantity of common electricity from a battery is independent of the surface over which it is spread; and next, that this effect is proportional to the absolute quantity of electricity. The measures by the galvanometer are not professedly very accurate; but it is to be expected that experiments more accurate in this respect, and more varied with regard to the quantity of electricity, would confirm these conclusions. Determining, then, the quantity of voltaic electricity which in a given time will produce the same deflection of the needle as a given quantity of common electricity discharged from a battery, he shows that voltaic electricity of the same intensity will also, in that time, produce the same degree of chemical decomposition which that quantity of common electricity will when passed from the con-

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* Phil. Trans. 1832, p. 280.

ductor. Although we are not quite satisfied with this manner of comparing the effects, because we consider that time enters very differently as an element in the several cases, yet we are sensible of the value of the experiments, and think that they strongly confirm the author's conclusions as to the identity of electricities from different sources.

This series of experimental researches in electricity, we consider, makes a very valuable addition to Mr. Faraday's former ones; and we have no hesitation in recommending its publication in the Transactions of the Royal Society.

S. H. Christie.

14th March 1833.

May 9, 1833.

WILLIAM GEORGE MATON, M.D., Vice-President, in the Chair.

A paper was read, entitled, "On the Anatomical and Optical Structure of the Crystalline Lenses of Animals, particularly that of the Cod." By Sir David Brewster, K.H., LL.D., F.R.S. V.P.R.S. Ed.

The author was led, by the observations he had made of some very singular phenomena in the crystalline lenses of fishes and quadrupeds when exposed to polarized light, to examine their minute anatomical structure, with the view of ascertaining if it had any relation to these optical appearances. He found that the crystalline lens of a cod has the form of a prolate spheroid, of which the axis coincides with that of vision. Its body is inclosed in an exceedingly thin and transparent capsule, within which it floats without having any apparent connexion with that capsule, and consists of a hard nucleus surrounded by softer matter. The nucleus is composed of regular transparent laminæ of equal thickness, with perfectly smooth surfaces, presenting the iridescent appearance peculiar to grooved surfaces, and exhibited by mother-of-pearl. These apparent grooves have the direction of meridian lines converging from the equator, where their breadth is greatest, to the two poles, and indicating the boundaries of the component fibres of the laminæ. The author was enabled to trace the course of these fibres to their termination very satisfactorily, when the fibres themselves could not be rendered visible by the best microscopes, by means of the reflected prismatic images of a luminous object, produced by interference. This method furnished also an accurate mode of determining the diameter of the fibres at any point of the spheroid. The uniform distribution of the light refracted through the lamina, as well as the distinctness of the reflected images, prove that these fibres are not cylindrical, but perfectly flat, and gradually tapering in breadth from the equator to the poles of the lens. The thickness of each fibre is at least five times less than its breadth, which, in the most external layer of the equator, is about the 5500th part of an inch.

The observation of another optical phenomenon apparent on looking at a bright light through a thin lamina of the lens of a cod, namely, that of two faint and broad prismatic images, situated in a line perpendicular to that which joins the common coloured images, led the author to the further discovery of the mode in which the fibres are united laterally to each other, so as to resist separation, and form a continuous spherical surface. By viewing a well-prepared lamina with a microscope of high magnifying power, he observed that the fibres are united by a series of teeth, locking into one another, exactly like those of rack-work. The breadth and depth of each tooth are about the fifth part of the breadth of the fibre itself, and all the adjacent surfaces are in perfect optical contact. This denticulated structure exists in the lenses of every fish which the author examined. In that of the cod, the number of teeth in each fibre was found to be 12,500; and since the number of fibres in the whole lens is 5,000,000, the total number of teeth amount to 62,500,000,000.

The same structure obtains universally, as far as the author has examined it, in the lenses of birds; but he has never met with it in any of the Mammalia, not even in the Cetacea. It was found in two species of lizards, and in the Ornithorhynchus.

In the concluding part of the paper the author enters into some details as to the doubly-refracting structure of the crystalline lens of the cod and of other animals, in which several curious varieties are observable with regard to the relative positions of the strata giving positive or negative double refractions. In the prosecution of this subject he was led to the observation of a series of very curious phenomena, which he announces as the subject of a future communication to the Royal Society.

A paper was also read, entitled, "On the present Situation of the Magnetic Lines of Equal Variation, and their Changes on the Terrestrial Surface." By Peter Barlow, Esq., F.R.S.

The author has undertaken the task of collecting and arranging all the authentic information respecting magnetic variation which has been recorded in the accounts of several recent voyages and journeys of discovery. The inconvenience from the distortion and interruptions of the lines of equal variation laid down on maps or charts, induced him to trace them on a globe, where they can, of course, be exhibited in their natural situation, and in regular continuity: and he has been careful to mark only such as are deduced from actual observation. The examination of the lines thus laid down shows them to be dependent on definite and general laws, and not on local influences; their inflexions and curvatures presenting systems of great regularity, and being exempt from those abrupt and angular configurations which such local disturbances might be expected to produce: neither do they appear to be consistent with the hypothesis of the action of a certain definite plurality of magnetic poles.

The author next offers some observations on the progressive changes which these lines undergo in their places and configurations, and shows their agreement with the hypothesis of a revolution of the magnetic poles for each place round the poles of the earth; each respective place having its own particular pole, the revolving motion of which is regulated by some general but hitherto unknown law.

May 16, 1833.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G., President, in the Chair.

A paper was read, entitled, "Note on a Paper by Dr. John Davy, entitled, 'Notice on the Remains of the recent Volcano in the Mediterranean.'" By Charles Daubeny, M.D., F.R.S., Professor of Chemistry in the University of Oxford.

From the circumstance that azotic gas is frequently evolved from thermal springs, the author infers that this phenomenon is in some way connected with volcanic action ; and this he considers to be the case in the instance observed by Dr. Davy, although referred by him to the decomposition of atmospheric air during putrefactive processes going on at the bottom of the sea. Dr. Daubeny offers objections to the theory of that gas rising to the surface in consequence of the high temperature to which it has been subjected. He conceives that the air which Dr. Davy examined cannot have been derived from sea-water, but must have originated from the atmosphere itself, with which the volcano communicated. The author is disposed to attach great importance to the accurate examination of the gases given out by warm springs, and recommends the prosecution of the inquiry.

A paper was also read, entitled, "Experimental Researches on Atomic Weights." By Edward Turner, M.D., F.R.S. Lond. and Edinb., Professor of Chemistry in the University of London.

This paper is a continuation of the Essay, by the same author, on the Composition of the Chloride of Barium, which was published in the Philosophical Transactions for 1829. Having shown that the atomic weights current among British chemists, though in some instances correct, or tolerably approximative, have, as a whole, been adopted on insufficient evidence, he proceeds, in this paper, to give an account of the experiments he has made to ascertain the equivalent numbers for lead, chlorine, silver, barium, and nitrogen. Finding, with reference to lead, that the method adopted by Berzelius did not afford uniform results, he endeavoured to ascertain the quantity of subsulphate of lead which given weights of metallic lead and the protoxide of that metal respectively produce. He details the mode he employed for the conversion of metallic lead into the subsulphate by a mixture of nitric and sulphuric acids, diluted with an equal bulk of water, and the precautions he adopted to avoid loss. The mean of three experiments gave 146·375 grains of sulphate of lead for 100 grains of metallic lead. By the mean of four experiments, Berzelius had obtained, instead of the former number, 146·419. Dr. Turner adopts the mean of the whole, namely, 146·41. By prosecuting this inquiry, he finds the sulphate to consist of 73·575 of protoxide of lead, and 26·425 of sulphuric acid; and that the former contains 5·274 of oxygen. According to these results, the equivalent number for lead is 103·6.

By experiments with the chloride of lead, which gave very uniform results, Dr. Turner obtained an equivalent number for chlorine, closely agreeing with that calculated from the analysis of chlorate of potash in the experiments of Berzelius, namely, 35·45, but totally inconsistent with the atomic weight assigned to it by British chemists. The accuracy of this result was further confirmed by a careful comparative analysis of the binoxide and bichloride of mercury.

The author next endeavoured to determine the equivalent number for silver, by the analysis of its oxide and sulphuret, but could not arrive at any precision in his results. The equivalent number for barium may be calculated from his analysis of the chloride already published in the paper before alluded to. His investigation of the equivalent of nitrogen was attempted by means of the analysis of the nitrates of silver, of lead, and of baryta; the mean result of which gives 14·15, agreeing very nearly with that assigned by Berzelius. His investigation of the atomic weight of sulphur is not yet completed; but he details several previous steps in this inquiry, which he intends to prosecute on a future occasion. He estimates the equivalent of mercury at 202; a number which he considers as a close approximation.

He concludes by various remarks on the inconsistency with experiment, which is apparent in many of the numbers adopted as chemical equivalents by British chemists; and on the inaccuracy of those numbers which have been employed as elements in calculating the equivalents of nearly all the other elementary substances. The author thinks that Dr. Prout's hypothesis, as advocated by Dr. Thomson, that all atomic weights are simple multiples of that of hydrogen, can no longer be maintained, and that it is at variance with the most exact analytical researches.

May 23, 1833.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G., President, in the Chair.

A paper was read, entitled, "Observations of the Comet of Encke, made in June 1832." By Thomas Henderson, Esq., His Majesty's Astronomer at the Cape of Good Hope. Communicated, by Command of the Lords Commissioners of the Admiralty, by Captain Beaufort, R.N., F.R.S., Hydrographer to the Admiralty.

Most of the observations recorded in this paper were made by a circular micrometer constructed by Simms, and applied to an achromatic telescope of Dollond's, 45 inches in focal length, and 3·5 inches aperture, furnished with a portable equatorial stand, capable of being adjusted to any latitude. The magnifying power was about 30, and the radius of the ring was an arc of 1015 seconds. In other observations, a transit instrument by Dollond was used, which was 10 feet in focal length, and 4·75 inches aperture. For observing the comet, an eye-glass magnifying 86 times was employed.

A paper was then read, entitled, "On the supposed Powers of Suction of the Common Leech." By Thomas Andrew Knight, Esq., F.R.S., President of the Horticultural Society.

From observing the feebleness of the muscular force exhibited by the leech in its progressive movements through the water, the author was led to doubt its possessing the powers of suction that are so universally ascribed to it. A fact which came under his notice above sixty years ago, of considerable loss of blood from the leg following the bite of a vigorous leech, suggested to him the idea that the animal might become filled with blood simply by the injection of its body, in consequence of the impetus with which the blood is made to flow into it from the part bitten ;—an impetus which he imagines may be occasioned by the introduction of a peculiar kind of venom. He considers the irritation which often accompanies the bite of a leech as corroborating this hypothesis : he admits, however, that the inflammation excited by the sting of a bee or a wasp is attended with effects of a totally opposite kind; for, in that case, the blood, instead of having a tendency to flow, stagnates around the point where the poison has been instilled.

A paper was also read, entitled, "Experimental Researches in Electricity.—Fourth Series." By Michael Faraday, Esq., D.C.L., F.R.S., Fullerian Professor of Chemistry in the Royal Institution of Great Britain.

The author, while prosecuting his researches on electro-chemical decomposition, observed some phenomena which appeared to be referable to a general law of electric conduction not hitherto recognised. He found that an electric current from a voltaic battery, which is readily conducted by water, did not pass through ice : even the thinnest film of ice, interposed in the circuit, was sufficient to intercept all electric influence of such low intensities as that produced by the voltaic apparatus, although it allows of the transmission of electricity of such high intensity as that excited by the common electrical machine. The author ascertained that a great number of other substances, which are solid at ordinary temperatures, do not conduct the electric current from the voltaic battery until they are liquefied. Among these are potassa, protoxide of lead, glass of antimony, and oxide of bismuth ; various chlorides, iodides, and sulphurets ; and also many of the ordinary neutral salts with alkaline bases. In almost every instance the bodies subjected to this law are decomposable by electricity ; and their decomposition can be effected only when they are in a fluid state, and while they are conductors of electricity. The author inquires how far these two properties are connected together, or dependent the one upon the other ; but finds that several exceptions occur to any general proposition that he attempted to establish on this subject.

The general conclusions to which he is led from the experiments detailed in this paper are the following:—First, that all bodies conduct electricity in the same manner, but in very different degrees;—Secondly, that in some the conducting power is powerfully increased by heat, in others diminished, and this without any difference that has yet been discovered, either in the general nature of the substance, or of the influence of electricity upon it;—Thirdly, that there is a numerous class of bodies which, when solid, insulate electricity, and, when fluid, conduct it freely, and are decomposed by it; yet that there are many fluid bodies which do not sensibly conduct electricity of low intensity; and some that conduct it, and are not decomposed;—and, Lastly, that fluidity is not essential to decomposition. Sulphuret of silver is the only body yet known to be capable of insulating a voltaic current when solid, and of conducting it, without decomposition, when fluid. No distinction can as yet be drawn between the conducting powers of bodies supposed to be elementary and those known to be compounds.

The Society then adjourned over Whitsun-week to the 6th of June.

June 6, 1833.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

Captain John Lihou, R.N., was elected a Fellow of the Society.

Professor Desfontaines, of Paris; Professor C. G. J. Jacobi, of Königsberg; Baron von Lindenau, of Gotha; Professor Meckel, of Halle; and M. G. de Pontécoulant, of Paris, were elected Foreign Members of the Society.

A paper was read, entitled, "An Account of a Second Series of Experiments on the Resistance of Fluids to Bodies passing through them." By James Walker, Esq., F.R.S., Civil Engineer.

The author, in a paper read to the Society in the year 1827, and printed in the Philosophical Transactions, gave an account of some experiments showing that the resistance of fluids increases in a ratio considerably higher than the square of the velocity, and that the absolute resistance is smaller than had been deduced from the experiments of the French Academy. In the present communication he states the results of his further inquiries on this subject. His experiments were made at the East India Docks, on a boat twenty-three feet long and six wide, with the stem and stern nearly vertical; one end being terminated by an angle of 42°, and the other of 72°; and the resistance to the boat's motion being measured by a dynamometer. The results are given in tables: and it appears from them, that in light vessels sharpness is more important in the bow than in the stern; but that the reverse is the case in vessels carrying heavy cargoes. From another series of experiments the author infers that the resistance to a flat surface does not exceed 1·25lb. for each square foot, at a speed of one mile per hour; increasing, for greater velocities, in a ratio considerably higher than the square of the velocity.

The author concludes with some observations on the results lately obtained in Scotland, where great velocities were given to boats moving on canals, without a proportional increase of resistance.

The reading of a paper, entitled, "Researches on the Arseniates, Phosphates, and Modifications of Phosphoric Acid," by Thomas Graham, Esq., M.A., F.R.S.E., Lecturer on Chemistry in the Andersonian Institution of Glasgow; communicated by Edward Turner, M.D., F.R.S.—was commenced.

June 13, 1833.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G., President, in the Chair.

Mr. Graham's paper was resumed and concluded.

The tendency of the arsenic and phosphoric acids to form subsesquisalts with the oxides of silver and lead is well known; corresponding salts with alkaline bases also exist. The author describes the method of forming the subarseniate and subphosphate of soda, and their properties; and shows that they are subsesquisalts, containing one proportion and a half of base to one of acid. They are the only known soluble salts of that constitution; and it is remarkable, that the acid of the subphosphate of soda is not convertible into pyrophosphoric acid by the action of heat, like the acid of the common phosphate of soda. This may be explained on the hypothesis, that phosphoric acid, in contradistinction to pyrophosphoric acid, contains an atom of water, which stands in a basic relation to the acid, and which may be replaced by an atom of any of the usual bases. Hence also arises the disposition of phosphoric acid to form subsesquisalts; for the common phosphate, used as a precipitant, exchanges its basic water for a fixed base; and for this reason, likewise, phosphate of soda, or any neutral phosphate, cannot be made anhydrous without becoming a pyrophosphate; but the subphosphates having an excess of base, may be anhydrous, as Stromeyer observed; and indeed they are not convertible into pyrosalts. The acid formed by the combustion of phosphorus in air or oxygen, constitutes a third modification of phosphoric acid, distinguished by peculiar properties, and which, from the difference of its saturating power, in relation to that of the phosphoric and pyrophosphoric acid, the author considers as a *polymeric* phosphoric acid;—a term lately applied by Berzelius to bodies of the same relative composition, but differing in their combining proportions.

The author devoted much time and attention to determine the quantity of water of combination in the foregoing subsalts; but the result he obtained, namely 50·22 per cent., is not easily reconciled with our best data for atomic weights. It is, however, pretty nearly compatible with 23 or 24 atoms of water, according to Berzelius's weight of the atom of arsenic; and if the latter estimate be correct, it is curious that the subarseniate differs from the neutral arseniate, merely by the substitution of an atom of soda for an atom of water; for the latter salt contains 25 atoms of water.

The author's experiments on the composition of the subarseniate of soda,—the results being reduced to the hypothesis, that it contains 23 atoms of water,—represent it as formed, (per cent.) of arsenic acid, 27·69; soda, 22·55; water, 49·75. The subphosphate of soda was found to consist (per cent.) of subsesquiphosphate, 43·97; water, 56·03; the soda in the salt amounting to 24·87.

The author attempted to determine the quantity of phosphoric acid in this salt, by direct precipitation by nitrate of silver, but could not obtain rigorously accurate results; for the subphosphate of silver carried down with it a portion of the nitrate, which washing could not entirely separate. He likewise failed in his endeavours to obtain pure subphosphate and subarseniate of potash.

The subarseniate of barytes appeared, by a single experiment, to be composed, (per cent.) of arsenic acid, 32·06; barytes, 67·94: from which the salt would seem to contain an excess of base; for by theory, the subsesquiarseniate of barytes should be composed of, acid, 33·4; base, 66·6.

When solution of muriate of lime is poured into an excess of solution of phosphate of soda, or when phosphate of lime, dissolved in muriatic acid, is precipitated by ammonia, a gelatinous mass is formed, which has been called the subphosphate of lime of bones; the composition of which is singular, consisting, on the simplest view that can be taken of it, of 3 atoms of phosphoric acid, and 4 of lime. It was noticed by Berzelius.

The author thinks the anomalous composition of this salt may in some measure be explained by considering it as consisting of 1 atom of the neutral, and 2 atoms of the subsesquiphosphate. According to Berzelius, calcined ox-bones are composed of such a phosphate of lime, with a little carbonate of lime; but a doubt arises of the accuracy of this view, from the fact, that the presence of carbonic acid in the calcined phosphate of bones is no proof of the existence of that acid in the same, previous to calcination.

The earth of bones, after calcination at a high temperature, contains phosphoric, and not pyrophosphoric, acid; the excess of base preventing the transition.

The author's analysis of subarseniate of lead, formed by the gradual addition of solution of acetate of lead to solution of subarseniate of soda, afforded a striking confirmation of the atomic weight of arsenic, deduced by Berzelius from his analysis of arsenious acid by sulphur.

A paper was read, entitled, "Some Observations on the Structure of Shells, and on the Economy of Molluscous Animals." By John Edward Gray, Esq. F.R.S.

The author distinguishes two kinds of structure in shells; the one in which the calcareous matter is crystallized, composing what Mr. Hatchett has called the *porcellaneous structure*; and the other, in which it is deposited in grains intermixed with a large proportion of animal matter, constituting the *nacreous* or *granular structure.* The former class of shells, which includes most of the turbinated univalves, may be divided into those in which the crystals are rhombic, and those in which they are prismatic. The first are composed of three distinct layers, the laminæ of which are disposed differently in the intermediate layer from what they are in the outer and inner layers. The direction of the fibres of each being nearly at right angles to that of the contiguous layer, the strength of the shell is rendered considerably greater than if the arrangement of the fibres had been uniform in each plate. The comparative thickness of the three plates varies in different shells; but the central plate is generally the thickest. The outer plate is the thinnest; and, in some shells, is easily detached, in consequence of the deposition underneath it of a white film of less coherent matter. It often happens, that when the animal arrives at its full size, it deposits layers of shell either on the lips or the columella: and in some, as the *Cypræœ,* an additional coat, which is harder, more compact, and differently coloured from the rest of the shell, is formed by an extension of the mantle, and laid on the outside of the shell; the part, where the two reflected portions of the mantle meet on the back being marked by what is termed the *dorsal line.*

Besides these component parts of turbinated shells, there is often deposited on the sides and interior part of their cavities, especially of the upper whorls, a transparent calcareous concretion. In shells of which the spires are elongated and acute, as in the *Turritellæ,* this deposition entirely fills up the cavity of the upper whorls; thus rendering solid the tips, which, from their small size and original thinness, would otherwise have been very liable to be broken. In other cases the animal, instead of filling up this upper cavity, suddenly withdraws its body from the upper whorls, and then forms a concave septum, by which the vital communication between the body and the apex of the shell being cut off, this part decays as a dead shell, and gradually falls to pieces.

Shells having a prismatic crystalline structure are formed of short fibres, everywhere perpendicular to the surface. The prisms are mostly hexagonal. Shells of a granular structure present a more uniform texture; the plates of animal matter they contain being very thin, and closely compacted together. They have generally a pearly or iridescent lustre, arising from this peculiar conformation. The particles of disintegrated *Placunæ* are employed by the Chinese as silver in their water-colour drawings. In many shells belonging to this class, as in the Oyster, the animal matter, being more abundant, produces a distinctly laminated texture.

It has been generally believed, and sometimes strenuously maintained, that molluscous animals have not the power of absorbing the matter of their shells when it has once been deposited. The author brings forward a large mass of evidence in proof of their frequently exercising this power. In the Cone and the Olive, all the septa between the whorls inclosed in the body are very thin and transparent, and, when compared with the corresponding portions of the outside, adjacent to the apex, are found to have lost the outer and the middle layers, the innermost alone remaining. In the *Auriculæ*, this inner layer also is removed, leaving a simple cavity in the upper half of the shell. The absorption of the substance of these internal portions of shell gives more space for the body, at the same time that it renders the shell much lighter, without any diminution of its strength; the body being sufficiently protected by the outer whorl. In the *Murices*, and other shells having ridges or spines on the front of the whorls, which, in the progress of the growth of the shell, the succeeding whorls would necessarily overlap, these appendages are generally absorbed, to make way for the succeeding whorls; their absorption being effected by the edge of the mantle as it comes in contact with them. Thus do many species of Mollusca absorb, at regular epochs of their growth, certain parts of their shells, which had, at a preceding period, been deposited about the lip in the form of ribs or teeth. Mollusca have also the power of forming excavations in the shells of other animals of this class, and sometimes of other individuals of the same species: many instances of these facts are adduced by the author; among which one of the most curious is the history of the *Spiraglyphus*, which, in the progress of its enlargement, absorbs a tubular portion of shell which it had formed at an early period of its growth. They also excavate portions of solid rock in providing for their habitation. Molluscous animals, however, do not appear to be capable of removing extraneous obstacles which oppose their progress in the formation of their shell; in proof of which, various examples are adduced of foreign bodies being inclosed in the layers of shells. The author produces evidence of the secretion of the materials of the shell by other parts than the mantle, and in particular by the upper part of the foot. The operculum is in this way formed, in a manner exactly similar to shell, by the back of the foot: and its various modifications of form, the author remarks, afford important characters for the systematic classification of this department of Natural History.

June 20, 1833.

WILLIAM GEORGE MATON, M.D., Vice-President, in the Chair.

His Grace the Duke of Buccleuch, and the Right Hon. Sir Thomas Denman, were elected Fellows of the Society.

Professor Stromeyer, Foreign Memb. R.S., presented two specimens, one of the coarse-grained, the other of the fine-grained variety, of the remarkable mass of iron lately discovered near Magdeburg, and an account of which had been laid before the Royal Society of Göttingen on the 14th of last month. This iron was found, in several detached lumps, about four feet below the mould, by Mr. Kote, who considered himself the more authorized to pronounce it meteoric, as, in the chronicles of Magdeburg, the descent of a fiery meteor is recorded as having happened in the year 998. Professor Stromeyer has subjected this iron to a minute analysis, the results of which are very interesting, inasmuch as, besides the alloy of nickel and cobalt, usually present in meteoric iron, he unexpectedly found a considerable portion of molybdenum,—a rare metal on our planet, occurring only in two combinations, viz. with sulphur, as glance molybdenum, and, as molybdic acid combined with oxide of lead, in the yellow lead ore of Carinthia and a few other places.

The following are the external characters of the six masses dug up, the largest of which was about fifty-seven pounds in weight; the others were considerably smaller. Their shape is more or less oval and flat, with surfaces rather oxidated, and here and there covered with an earthy crust. The larger lumps did not exhibit any trace of scoriæ; but in some of the smaller pieces, part of the metallic mass had passed into a porous slag-like body; of which latter a few detached pieces were likewise found. This iron possesses no degree of ductility; it is not attacked by the saw, and but slightly and with difficulty by the file. Its tenacity, however, is considerable; the masses required great strength to be broken; but small fragments did not oppose greater difficulty to be reduced to a coarse powder than white cast-iron; and glass was but slightly scratched by them. On the fresh fracture, this iron exhibits upon the whole a scaly-granular structure; its internal lustre is moderately vivid, and its colour tin-white, with a strong cast of grey. Two varieties of texture were, however, observable; in some fragments it was more distinctly scaly, of a coarser grain and a deeper grey colour, united to a greater degree of tenacity. The specific gravity of the coarse-grained variety (barom. 0^{in}·758, therm. 21°·5 c.) = 7·2182; that of the fine-grained = 7·3894.

The mass contained much of a sulphuret not unlike in appearance to variegated copper ore, from which the subsequent analysis proved it not to differ in composition, except that a trace of sulphuret of silver was found in it. Also minute portions of capillary native copper were found in the interior of some pieces, together with here and there some translucid, pale yellow, olivine-like grains, but in too small quantities to admit of chemical examination.

Professor Stromeyer proceeds to give a detailed account of the chemical analysis to which this iron was subjected by him; according to which 100 parts are composed of—

	a. *Coarse-grained variety.*	b. *Fine-grained variety.*
Iron	76·77	74·60
Molybdenum . . .	9·97	10·10
Copper	3·40	4·32
Cobalt	3·25	3·07
Nickel	1·15	1·28
Manganese . . .	0·02	0·01
Arsenic	1·40	2·47
Silicium	0·35	0·39
Phosphorus . . .	1·25	2·27
Sulphur	2·06	0·92
Carbon	0·38	0·48
	100·00	100·00

From this it appears, that though the Magdeburg iron contains all the ingredients characteristic of meteoric iron, it is essentially distinct from all others hitherto examined, by the presence of molybdenum and arsenic; by the smaller and rather anomalous proportion of nickel and cobalt which enters into its composition; by the admixture of some capillary copper and of variegated copper ore, instead of the magnetic pyrites found in some meteoric iron; and, lastly, by the presence, though only a trace, of sulphuret of silver.

Professor Stromeyer then enters into an examination of the circumstances which appear opposed to the opinion which assigns a meteoric origin to this iron, and of the objections against its being the product of artificial fusion; among which, one of the greatest is its considerable alloy of molybdenum,—a metal which has hitherto not been observed either in ores of iron and copper, or in any slags or other products of smelting furnaces. But Dr. Stromeyer has since obtained, from the Hartz Mountains, a similar and equally problematical mass of iron, the analysis of which has furnished nearly the same results as that of the Magdeburg iron, except that it contained no variegated copper ore. Future observations will probably throw more light upon the nature of these enigmatical metallic bodies; at all events, the discovery of molybdenum in them is so far of great interest, as, in case they should ultimately prove to be artificial products, it is fair to conjecture that that scarce metal must enter into combinations still unknown to the chemical mineralogist, or occur in some ores in a masked state and such small proportions as to become (like titanium) apparent only in the products of the long-continued operations of the smelting furnace.

The following papers were read:—

1. "Observations on the Physiology of the Nerves of Sensation, illustrated by a case of Paralysis of the Fifth Pair." By John Bishop, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

The influence of the fifth pair of nerves on the functions of sight, smell, and taste, is a subject which has lately occupied the attention of physiologists. Many experiments have been made on living animals with a view to its elucidation; but these experiments have never led to any satisfactory conclusion. Considerable light has been thrown upon this obscure question by the phenomena attending a case of paralysis of the fifth pair of nerves, which occurred in the author's practice, and of which he gives the history in detail, after quoting the account given by Magendie of his experiments and speculations respecting the functions of these nerves.

The lady who was the subject of these observations had been affected with total insensibility of the left side of the face and head, together with strabismus, accompanied with double vision; but the powers of voluntary motion of all these parts remained entire. The globe of the left eye was quite insensible to touch, though it retained the power of vision unimpaired, excepting that for some time previous to death it had lost the faculty of distinguishing colours. The left nostril received no impressions from the most irritating stimulants, such as snuff or ammonia; yet the sense of smelling continued unimpaired. The left side of the tongue was quite insensible to impressions both of touch and of taste. On examining the brain after death, a scirrhous tumour was found lying on the inner surface of the sphenoid bone, extending laterally to the foramen auditorium internum, and resting posteriorly on the pons Varolii, which was slightly ulcerated. The tumour had completely obliterated the foramina for the exit of the three branches of the fifth pair of nerves. This case proves, therefore, that, contrary to the opinion of Magendie, the senses of smell and vision can be exercised independently of the fifth pair of nerves; and that the sense of taste is altogether derived from that nerve; and corroborates the views of Sir Charles Bell on this part of physiology.

2. " On the Respiratory Organs of the Common Leech (*Hirudo officinalis*, Linn.), and their Connexions with the Circulatory System." By George Newport, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

The stomach of the leech has been hitherto described as a large elongated sac, simply divided into ten compartments by perforated membranous partitions: but the author, by a more accurate examination, finds that each portion of that organ is expanded into two lateral cæca, which increase both in size and in length as they are traced along the canal towards the pylorus. The cæca belonging to the tenth cavity are the longest, extending as far as the anus, and have themselves four constrictions: the cavity itself terminates in a funnel-shaped pylorus. When the posterior end of the animal is cut off, the cæcal portions of the stomach are laid open, and the blood which it receives flows out freely, as fast as it is swallowed; and hence the leech, under these circumstances, continues to suck for an indefinite time.

The respiratory organs consist of two series of pulmonary sacs, arranged along the under side of the body, on each side of the nervous cords and ganglia. They each open upon the surface of the body by a very minute but distinctly valvular orifice. The membrane which lines them appears to be continuous with the cuticle, and is exceedingly delicate and highly vascular, receiving the blood, for the purpose of its being aerated, from the veins of the system. The blood is returned from these sacs into the lateral serpentine vessels by vessels of a peculiar construction, passing transversely, and forming loops, which are situated between the cæca of the stomach, and which are studded by an immense number of small rounded bodies closely congregated together, and bearing a great resemblance to the structure of the venæ cavæ of the cephalopodous Mollusca. The purpose answered by this structure is involved in much obscurity: the author offers a conjecture that they may be analogous in their office to the mesenteric glands of the higher animals.

With a view to determine some circumstances relating to the mode of the respiration of the leech, the author made some experiments, by confining the animal in water deprived of air by boiling. After some time the leech was observed to give out bubbles of air; and the water of the vessel, when tested by lime-water, indicated the presence of carbonic acid.—The paper is accompanied by drawings of the structures described.

3. "On the Comparative Osteological Forms in the Adult European Male and Female of the Human Species." By Walter Adam, M.D., Fellow of the College of Physicians of Edinburgh.

With a view to the future investigation of the osteological developement of the human race, the author gives, in the present paper, the results of a great number of measurements, which he has very carefully made, of the dimensions of the different bones composing the adult human skeleton. The male bones examined were those in the collection of Dr. Monro; the female bones were furnished by Dr. Hamilton. The author was anxious to fix on some one dimension in the skeleton which might be taken as the standard of all the measurements: and finding that no bone of the trunk or limbs possessed the requisite characters for that purpose, he sought for it in the cranium; and the result of an extensive series of observations led him to adopt as the standard of measure the distance between the prolongations of the zygomatic ridges, immediately over the meatus auditorius externus, as being that dimension which was less liable to variation than any other of the human cranium. This line he denominates the *auricular transverse*; and, adopting a scale of which the unit is the 14th part of this line, being generally about the third of an inch, he states at length, in multiples of this unit, the dimensions, in different directions, of almost every bone in the skeleton; noting more especially the differences that occur in those of the two sexes. Of these measurements, which are given in much detail, and in many instances arranged in a tabular form, it is impossible to give any abridgement. The conclusion he deduces from his inquiry is, that every bone in the body exhibits certain modifications, according to the sex of the individual.

4. "Some Experiments and Observations on the Combinations of Carbonic Acid and Ammonia." By John Davy, M.D., F.R.S.

The author was led to the investigations of which he gives an account in the present paper, by finding in the note-books of his brother, the late Sir H. Davy, some memoranda of experiments which he had made on the salts of ammonia, and more especially on the carbonates. The first part of the paper relates to the direct combination of carbonic acid and ammonia, by which a salt is formed possessing singularly alkaline properties. The second is on the sesquicarbonate of ammonia; a term which Mr. Richard Phillips has applied to that salt of ammonia which is commonly called the subcarbonate, and which is obtained by the mutual decomposition of carbonate of lime and salammoniac, by means of heat. This the author concludes, from his experiments, to be composed of one proportion ammonia, one and a half of carbonic acid, and one of water. He then enters into a comparative review of the analyses of this salt by other chemists, and gives an account of the results of his experiments to determine its solubility at different temperatures. He next proceeds to consider the bicarbonate of ammonia, which he finds to consist of one proportion of ammonia, two of carbonic acid, and two of water. He concludes by an inquiry into the effects of heat on the solid sesquicarbonate and the carbonate of ammonia, in which he reviews the experiments and inferences which Sir H. Davy has recorded in his manuscript notes.

5. "On the Influence of Colour on Heat and Odours." By James Stark, M.D., of Edinburgh. Communicated by Sir David Brewster, K.H., LL.D., F.R.S. V.P.R.S. Ed.

The author observes, that the only experiments on record relating to the modifying effect of different colours on the absorption of heat from solar light, are those of Franklin and of Sir H. Davy. In order to investigate this subject, the author employed pieces of wool, silk, and cotton, which were wrapped round the bulb of a thermometer placed in a glass tube: the tube was then plunged into boiling water, and the time which elapsed during the rise of the thermometer from one given point to another was accurately noted. Other experiments were also made with an air-thermometer, of which the bulb was coated with various coloured materials, and heat thrown on the ball by means of polished tin reflectors from an Argand burner. The results accord very nearly with those of Franklin and of Davy; the absorbing power with regard to different colours being nearly uniformly in the order of *black*, *brown*, *green*, *red*, *yellow*, and *white*. The author next investigates the differences which occur in the radiation of heat by differently coloured substances; a subject on which he is not aware that any experiments have ever been made previously to his own. The mode of ascertaining the amount of radiation was generally the converse of that by which the absorption of heat had been determined; namely, by exposing the coloured substances, in contact with a thermometer, to cooling instead of heating processes. The general result of all his experiments was, that the loss of caloric by radiation follows exactly the same order, with regard to the colour of the radiating surface, as its absorption.

In the second part of his paper the author gives an account of a course of experiments which he made with a view to discover the influence of colour on the absorption of odorous effluvia, and more especially in the case of the absorption of the fumes of camphor and assafœtida by woollen cloth of different colours. Black cloth was always found to be possessed of the greatest absorbing powers, and white of the least; red cloth being intermediate between them. Cottons and silks gave, on trial, precisely the same results, which were further confirmed by the different weights acquired by these substances from the deposition of camphor upon them.

6. "Researches on the Arseniates, Phosphates, and Modifications of Phosphoric Acid." By Thomas Graham, Esq., M.A, F.R.S.E., Lecturer on Chemistry in the Andersonian Institution at Glasgow. Communicated by Dr. Turner, F.R.S.

This paper, which forms the sequel to the one on the same subject which was read at the preceding meeting, continues the inquiry into the combinations of phosphoric acid with different bases, and more particularly with soda. The crystallized salt of phosphate of soda was found to contain 37·1 of the phosphate, and 62·9 of water; so that the author infers its composition to be three atoms base, namely, two of soda and one of water. The pyrophosphate of soda, on the other hand, contains only two atoms soda as base, and gives accordingly bibasic precipitates. The biphosphate of soda was found to admit of so great a number of changes in its composition and properties, as to render it an object of great interest. Of the four atoms of water which the crystals contain, they lose two atoms at the temperature of 212°, and not a particle more till the heat is raised to about 375°. There is every reason to believe that the two atoms of water retained are essential to the constitution of the biphosphate of soda; and that it contains three atoms of base, namely, one atom soda to two atoms water, united to a double atom of phosphoric acid. Other varieties of this salt are also met with; the first of which may be called a bi-pyrophosphate, containing only one atom of basic water; the second being anhydrous, though soluble in water, and neutral in its reaction on litmus, but of which the exact composition is not well determined; the third being an insoluble variety; and a fourth being a metaphosphate of soda,—the author designating, by the term Metaphosphoric acid, a peculiar hypothetical state of composition of the elements of phosphoric acid in conjunction with water. This new acid enters into combination with barytes and with lime, forming with these bases other metaphosphates. The author concludes by a general review of the several modifications of phosphoric acid which have resulted from these inquiries.

7. "On the Developement of the Disturbing Function upon which depend the Inequalities of the Motions of the Planets, caused by their Mutual Attraction." By James Ivory, Esq., K.H., M.A., F.R.S.

The progress of physical astronomy has been retarded by the excessive labour requisite for the arithmetical computation of the inequalities in the motions of the planets, arising from the perturbations produced by their mutual attractions. If an inequality depended solely on the quantity of the coefficient of its argument in the expanded algebraic function, the difficulty of computation would not be great, since, from the smallness of the elements on which it depends, namely, the eccentricities and the inclinations of the orbits to the ecliptic, the resulting series decreases, in every case, with great rapidity: but as its magnitude depends also upon the length of its period, the coefficient of its argument will, when this period embraces many years, acquire, in the process of integration, a high multiplier, and comes thus to have a sensible effect on the place of the planet.

Such is the origin of some of the most remarkable of the planetary inequalities, and, in particular, of the great equations in the mean motions of Jupiter and Saturn. It is necessary, therefore, that the astronomer be furnished with the means of computing any term in the expansion of the disturbing function below the sixth order; since it has been found that there are inequalities depending upon terms of the fifth order, which have a sensible effect on the motions of some of the planets. The object of the author in the present paper is to give the function such a form that the astronomer may have it in his power to select any inequality he may wish to examine, and to compute the coefficient of its argument by an arithmetical process of moderate length. The investigation comprehends every argument not passing the fifth order; but as the formulæ are regular, the method may be extended indefinitely to any order.

8. "On the Reflex Function of the Medulla Oblongata and Spinalis, or the principle of Tone in the Muscular System." By Marshall Hall, M.D., F.R.S. L. & E.

The author, after commenting on the opinions of Le Gallois and Cruveilhier relating to the functions of the spinal marrow, adverts to a property or function of the medulla oblongata and spinalis, which he considers as having escaped the notice of these and all other physiologists; namely, that by which an impression made upon the extremities of certain nerves is conveyed to these two portions of the nervous system, and reflected along other nerves to parts different from those which received the impression. He distinguishes muscular actions into three kinds: first, those directly consequent on volition; secondly, those which are involuntary, and dependent on simple irritability; and thirdly, those resulting from the reflex action above described, and which include those of the sphincter muscles, the tonic condition of the muscles in general, the acts of deglutition, of respiration, and many motions, which, under other circumstances, are under the guidance of the will. Volition ceases when the head or brain is removed; yet, as he shows by various experiments, movements may be then excited in the muscles of the limbs and trunk, by irritations applied to the extremities of the nerves which remain in communication with the spinal marrow: but these actions cease as soon as the spinal marrow is destroyed. Hence the author concludes that they are the effect of the reflex action of the spinal marrow, which exists independently of the brain; and, indeed, exists in each part of the organ independently of every other part. He considers that this reflex function is capable of exaltation by certain agents, such as opium and strychnine, which in frogs produce a tetanic and highly excitable state of muscular irritability. Hence he is led to view the reflex function as the principle of tone in the muscular system. He considers that certain poisons, such as the hydrocyanic acid, act by destroying this particular function. The effects of dentition, of alvine irritation, and of hydrophobia, of sneezing, coughing, vomiting, tenesmus, &c. &c., are adduced as exemplifications of the operation of the same principle when in a morbid state of exaltation.

9. "Experimental Researches in Electricity.—Fifth Series." By Michael Faraday, Esq., D.C.L., F.R.S., Fullerian Professor of Chemistry in the Royal Institution of Great Britain.

The object of the author in this paper is to investigate the nature of electro-chemical decomposition. From the consideration of the circumstances of difference that mark the electricities obtained from the common electrical machine, and from the voltaic battery, and of which he had already established the theory in preceding papers, he was led to expect that the employment of the former in effecting chemical decomposition would exhibit some new conditions of that action, evolve new series of the internal arrangements and changes of the substance under decomposition, and perhaps give efficient powers over matter as yet undecomposed. For the purpose of greater distinctness, he divides the inquiry into three heads. In the first, he treats of some new conditions of electro-chemical decomposition, and shows that that effect does not depend upon the simultaneous action of two metallic plates, since a single pole might be used to effect decomposition; in which case one or other of the elements liberated passes to that pole, and the other element to the other extremity of the apparatus, the air itself acting as a pole. In the second, he considers the influence of water in electro-chemical decomposition; and he combats the opinion that the presence of that fluid is essential to the process is erroneous, and shows that water is merely one of a very numerous class of bodies, by means of which the electric influence is conducted and decomposition effected. In the third, he enters at large into the investigation of the theory of electro-chemical decomposition; and after discussing at some length the various theories of different writers on this curious subject, he is led to consider the effect in question as produced by an internal corpuscular action, exerted according to the direction of the electrical current, and as being the result of a force either superadded or giving direction to the ordinary chemical affinity of the bodies present; that is, modifying the affinities in the particles through which the current is passing, so that they act with greater force in one direction than in another, and consequently cause them to travel, by a series of successive decompositions and recompositions, in opposite directions, so as to be finally disengaged at the boundaries of the decomposing body. Various experiments are detailed in corroboration of these views, which appear to explain, in a satisfactory manner, all the prominent features of electro-chemical decomposition.

10. "The Anatomy and Physiology of the Liver." By Francis Kiernan, Esq., M.R.C.S. Communicated by J. H. Green, Esq., F.R.S.

After giving a short account of the descriptions of Malpighi and other writers respecting the minute structure of the liver, the author proceeds to state the results of his own investigations on this subject. The hepatic veins, together with the lobules which surround them, resemble in their arrangement the branches and leaves of a tree; the substance of the lobules being disposed around the minute branches of the veins like the parenchyma of a leaf around its fibres. The hepatic veins may be divided into two classes; namely, those contained in the lobules, and those contained in canals formed by the lobules. The first class is composed of interlobular branches, one of which occupies the centre of each lobule, and receives the blood from a plexus formed in the lobule by the portal vein; and the second class of hepatic veins is composed of all those vessels contained in canals formed by the lobules, and including numerous small branches, as well as the large trunks terminating in the inferior cava. The external surface of every lobule is covered by an expansion of Glisson's capsule, by which it is connected to, as well as separated from, the contiguous lobules, and in which branches of the hepatic duct, portal veins and hepatic artery ramify. The ultimate branches of the hepatic artery terminate in the branches of the portal vein, where the blood they respectively contain is mixed together, and from which mixed blood the bile is secreted by the lobules, and conveyed away by the hepatic ducts which accompany the portal veins in their principal ramifications. The remaining blood is returned to the heart by the hepatic veins, the beginnings of which occupy the centre of each lobule, and when collected into trunks pour their contents into the inferior cava. Hence the blood which has circulated through the liver, and has thereby lost its arterial character, is, in common with that which is returning from the other abdominal viscera, poured into the vena portæ, and contributes its share in furnishing materials for the biliary secretion. The paper is accompanied by numerous drawings of preparations made by the author, of the minute structure of the liver, in which the different sets of vessels and ducts were injected in various ways.

The Society then adjourned over the Long Vacation to the 21st of November next.